

A second silicon oxide layer is deposited on the first silicon oxide layer by biasing the plasma toward the substrate while maintaining application of the sputtering power to the reactants.

REMARKS

Claims 16-36 are pending. Claims 16-18, and 32 have been amended to more particularly point out and distinctly claim Applicants' invention. No new matter has been introduced. Applicants believe the claims comply with 35 U.S.C. § 112.

Claim 16 is Novel over Onuki et al.

Claim 16 stands rejected under 35 U.S.C. § 102(b) as being anticipated by Onuki et al. Applicants respectfully assert that claim 16 is novel and patentable over Onuki et al. because, for instance, Onuki et al. does not teach or suggest maintaining a plasma by coupling sputtering energy into the processing chamber to deposit a first layer of a film on a substrate by sputtering without biasing the plasma toward the substrate and, thereafter, maintaining the plasma by maintaining coupling of the sputtering energy into the chamber and biasing the plasma toward the substrate to deposit a second layer of the film over the first layer.

Onuki et al. discloses a switching bias sputtering process whereby d.c. sputtering and d.c. bias sputtering are operated alternately (page 182, right column, lines 9-11). As illustrated in Figs 1 and 2, the switching bias sputtering process involves alternating step pulses of sputtering power and bias voltage. The step pulses of sputtering power and bias voltage alternate, and do not overlap in time. The use of the switching bias sputtering method is intended to enhance the step coverage and quality of Al films (page 182, right column, lines 12-13).

In contrast, claim 16 recites maintaining a plasma to deposit a first layer by sputtering without biasing the plasma toward the substrate and, thereafter, maintaining the plasma by maintaining coupling of the sputtering energy into the substrate processing chamber and biasing the plasma toward the substrate to deposit a second layer. The sputtering energy coupled into the chamber to form the plasma is maintained during biasing of the plasma to deposit the second layer. The first layer formed without biasing the plasma is a reduced stress layer for reducing the stress of films deposited on the substrate (Page 4, lines 1-3 and Abstract).

Onuki et al. specifically discloses terminating the sputtering power during application of the bias voltage. Onuki et al. does not teach or suggest the features recited in claim 16. Nor does it suggest the deposition of a reduced stress layer. Therefore, claim 16 is novel and patentable over Onuki et al. ✓

Claims 17-19 and 25-31 are Patentable

Claims 17, 18, and 25-28 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ye et al. in view of Onuki et al., Boys et al., and Ramarotafika et al. Claims 19 and 29-31 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ye et al. in view of Onuki et al., Boys et al., Ramarotafika et al., and Matsuura.

Applicants respectfully assert that independent claim 17 is patentable over the cited references because, for instance, they do not disclose or suggest controlling the plasma generation system to form a plasma from the process gas by coupling sputtering energy into the chamber and deposit a first layer of the film over the substrate by sputtering without biasing the plasma towards the substrate, and controlling the plasma generation system to maintain the plasma by maintaining coupling of the sputtering energy into the chamber and bias the plasma toward the substrate to deposit a second layer of the film over the first layer. SAME

The Examiner recognizes that Ye et al. does not teach a controller or the memory storing a program for directing the operation of the system to deposit a first layer without biasing of the plasma and a second layer with biasing of the plasma, as recited in claim 17. The Examiner relies on Onuki et al. for allegedly disclosing the deposition of a first layer without biasing and a second layer with biasing.

As discussed above in connection with claim 16, Onuki et al. specifically discloses terminating the sputtering power during application of the bias voltage. Onuki et al. is devoid of any teaching or suggestion for maintaining the plasma by maintaining coupling of the energy into the chamber and biasing the plasma toward the substrate to deposit a second layer of the film as recited in claim 17.

The remaining references do not cure the defects of Ye et al. and Onuki et al. The Examiner cites Boys et al. merely for allegedly disclosing a programmable memory controller for controlling a plasma deposition system. Ramarotafika et al. describes the influence of d.c. substrate bias on the resistivity, composition, crystallite size, and microstrain

of WTi and WTi-N films. Matsuura discloses silicon oxide films in a semiconductor device allegedly having superior crack resistance, superior step coverage, and superior recess-filling characteristics (col. 3, lines 17-32 and Abstract). None of them teach or suggest maintaining the plasma by maintaining coupling of the energy into the chamber and biasing the plasma toward the substrate to deposit a second layer over the first layer of the film. / *Sparks*

Moreover, Applicants contend that the rejection based on the combination of the references benefits from the exercise of hindsight. The references are directed to very different processes for forming different films to achieve different purposes. For example, Onuki et al. is directed to forming sputtered Al and Al alloy films using switching bias sputtering involving d.c. sputtering and d.c. bias sputtering; Ramarotafika et al. is directed to forming WTi and WTi-N films by r.f. magnetron sputtering with d.c. substrate bias; and Matsuura relates to deposition of silicon oxide films by plasma CVD. There is no suggestion that the operating conditions for depositing silicon oxide layers in Matsuura can be combined with the switching bias sputtering technique taught in Onuki et al. For at least the foregoing reasons, Applicants respectfully submit that claim 17 is patentable.

Claims 18, 19, and 25-31 depend from claim 17, and are submitted to be patentable as being directed to additional features of the invention, as well as by being dependent from allowable claim 17. For instance, claim (25) recites that the plasma is an inductively coupled plasma. Claim (26) recites that the inductively coupled plasma is formed from the process gas using only RF energy applied to a coil disposed about the processing chamber. Claim (28) recites that electrical energy is applied to the first and second electrodes while maintaining the application of the RF energy. Claim (29) recites that the process gas includes flows of silicon and oxygen. The incorporation of these features into the system of claim (27) is completely absent from the cited references. *NOT*

Claims 20-22 are Patentable

Claims 20-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ye et al. in view of Onuki et al., Boys et al., Ramarotafika et al., and Matsuura. Applicants respectfully assert that claims 20-22 are patentable over the references because, for instance, the references fail to teach or suggest means for generating a plasma from the reactants by applying a sputtering power to the reactants to deposit a first layer of a film on the

substrate, and means for biasing the plasma toward the substrate to enhance a sputtering of the plasma while maintaining application of the sputtering power to the reactants and deposit a subsequent layer, as recited in claim 20 from which claims 21 and 22 depend.

As discussed above, Onuki et al. discloses terminating the sputtering power during application of the bias voltage. The remaining references are devoid of any suggestions for maintaining application of the sputtering power to the reactants while biasing the plasma toward the substrate to enhance a sputtering of the plasma to deposit a second layer over the first layer, as recited in claim 20. In addition, Onuki et al. fails to disclose the pressure range recited in claim 21 and the temperature range recited in claim 22. Matsuura discloses pressure and temperature ranges for depositing silicon oxide layers, but provides no motivation for employing those ranges for switching bias sputtering of Al and Al alloy films as taught in Onuki et al.

For at least the foregoing reasons, Applicants respectfully submit that claims 20-22 are patentable.

Claims 23, 24, and 36 are Patentable

Claims 23 and 24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ye et al. in view of Onuki et al., Boys et al., Ramarotafika et al., and Matsuura.

Applicants respectfully assert that claims 23 and 24 are patentable over the references because, for instance, the references do not teach or suggest an insulating layer formed between the metal layer and the semiconductor substrate and including a first silicon oxide layer and a second silicon oxide layer deposited using a high-density plasma chemical vapor deposition process, where the first silicon oxide layer is deposited for the reduction of mechanical stress in the second silicon oxide layer, as recited in claim 23 from which claim 24 depends.

Applicants respectfully assert that the Examiner has not established a *prima facie* case of obviousness, since the Examiner has not pointed to anything in the references that would suggest the claimed invention. Neither Onuki et al. nor Ramarotafika et al. teach depositing silicon oxide layers. Matsuura discloses silicon oxide layers, but fails to teach or suggest a first silicon oxide layer deposited for reduction of mechanical stress in the second silicon oxide layer.

metal
IL SiO₂
SS

Claim 36 depends from claim 23, and further recites that the first silicon oxide layer is deposited on the substrate by placing the substrate in a process chamber and applying a sputtering power to reactants to generate a plasma in the process chamber, and that the second silicon oxide layer is deposited on the first silicon oxide layer by biasing the plasma toward the substrate while maintaining application of the sputtering power to the reactants. These features are completely absent from the references. SAME AS ABOVE

For at least the foregoing reasons, Applicants respectfully submit that claims 23, 24, and 36 are patentable.

Claims 32-35 are Patentable

Claims 32-34 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ye et al. in view of Onuki et al., Boys et al., and Ramarotafika et al. Claim 35 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ye et al. in view of Onuki et al., Boys et al., Ramarotafika et al., and Matsuura.

Applicants respectfully submit that independent claim 32 is patentable because, for instance, the references do not disclose or suggest controlling the plasma generation system to form a plasma from the process gas by coupling sputtering energy into the processing chamber to deposit a first layer over a substrate by sputtering without biasing the plasma towards the substrate, and controlling the plasma generation system to maintain the plasma by maintaining coupling of the sputtering energy into the processing chamber and to bias the plasma toward the substrate to deposit a second layer of the film over the first layer. SAME

As discussed above, Onuki et al. discloses terminating the sputtering power during application of the bias voltage, and the remaining references fail to suggest maintaining coupling of the energy into the chamber while biasing the plasma to deposit the second layer.

In addition, the references do not teach incorporating into the computer instructions of claim 32 the inductively coupled plasma recited in claim 33, the high density plasma system recited in claim 34, and the flows of silicon and oxygen in the process gas recited in claim 35. Accordingly, Applicants respectfully submit that claims 32-35 are patentable over the cited references.

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In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 650-326-2400.

Respectfully submitted,

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